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The Cultivation of Sugar Beet.

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THE CULTIVATION OF SUGAR BEET.

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Nature of the Crop.—The sugar beet is a root plant of the same family as the mangold. Properly cultivated it is a long tapering root, of a shape and colour similar to a parsnip, but larger and broader at the top (Fig. 1). Its weight, excluding the crown and leaves, averages from $1\frac{1}{2}$ to 2 lb. If through shallow cultivation it develops fangy roots it loses in sugar content. It has a heavy green foliage. Unlike the mangold it grows almost entirely below the surface. The beet develops innumerable rootlets and root hairs, absorbing water and plant-food to feed the plant, which permeate and ventilate a wide radius of soil (Fig. 2). These are detached in the act of lifting the beet.

Sugar Content.—Formerly the sugar beetroot (or white mangold) only contained 6 per cent. of sugar, but after selection of seed over many years the plant now produces and stores in the root from 15 to 20 per cent. of its net weight of sugar. All commercial seed used in sugar beet cultivation for the production of sugar is grown from "mother seed" which is carefully propagated from year to year at seed producing stations under the control of scientists trained in this special branch of the work. If seed were grown the second year from the commercial sugar beet the plant would be inclined to "throw back," and the beets grown therefrom would be of no value for sugar production. The sucrose or sugar in the beet is the product of air, light and water. It is produced in the leaves and stored in the root. When the leaves have done their work they become greenish yellow and wilt. The top or crown of the root (from below the lowest leaf or bud) is removed on the field (Fig. 1) as it contains the smallest percentage of sugar and the greatest amount of impurity. It is therefore useless for sugar extraction, and is in fact harmful to the manufacturing processes.

Climate.—It has been proved that the climate of England is eminently suitable for the crop. This was amply shown in the bulk cultivation of beet which took place during the exceptionally sunny but dry season of 1921, and the correspondingly wet and sunless season of 1922. In both these years the sugar content in the beet averaged over 16 per cent. The Eastern Counties of England most resemble the chief beet-growing districts of the Continent, but satisfactory crops of beet have been grown in most parts of this country south of the Humber, and there is no reason to suppose that the crop might not be successfully grown still further north.

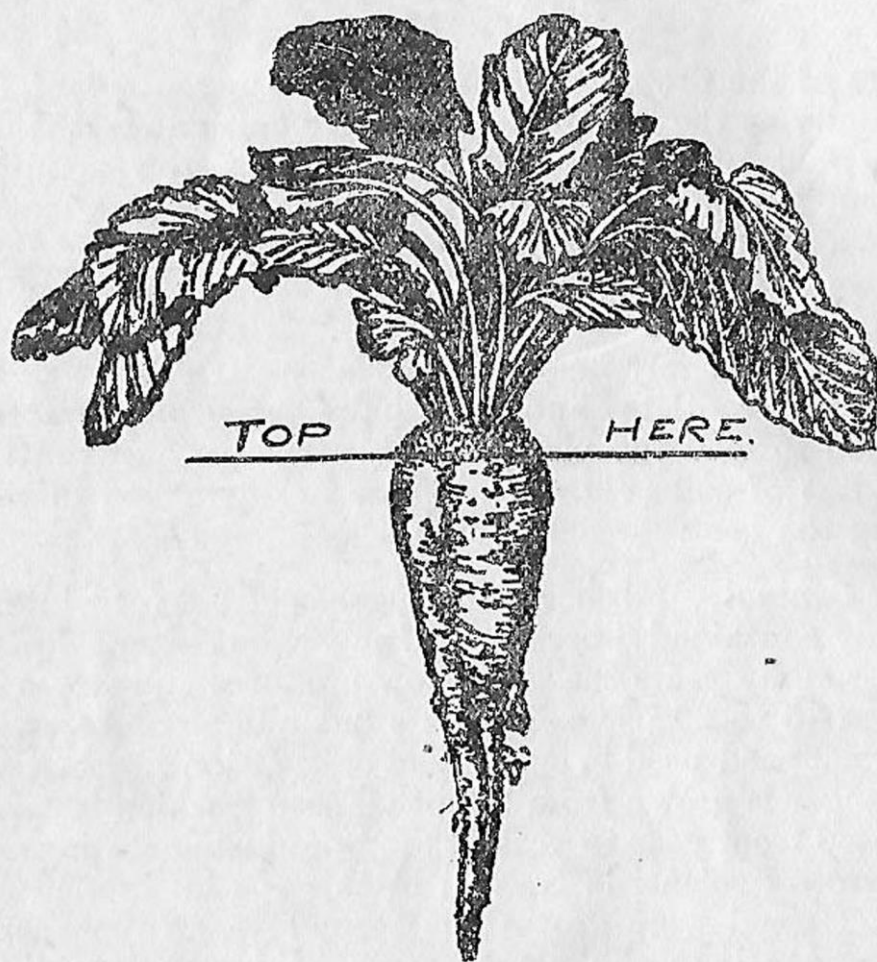


FIG. 1.—A typical Sugar Beet, showing correct Method of Topping.

Soil.—The best soils are deep loams, well supplied with lime and organic matter. Any free-working soil, however, adapted for growing roots, barley or potatoes should grow beets well. Even with strong clays the beet can be made to thrive with liberal treatment of the soil, the main objection being the increased labour in lifting a deep root, although a high sugar content is usually obtained. Very shallow soils should not be

used. Instead of a long tapering root, the beet takes a mangold shape and develops fangy roots. Deformed roots are also caused by insufficiently drained soil.

Rotation.—Sugar beet can be grown several years in succession on the same land, but this is not recommended. Each year the crop becomes lighter and is more liable to attack by pests, especially if the tops and leaves have been ploughed in. It is more economical to grow the beet crop as the cleaning crop in the rotation, replacing mangolds, swedes or common

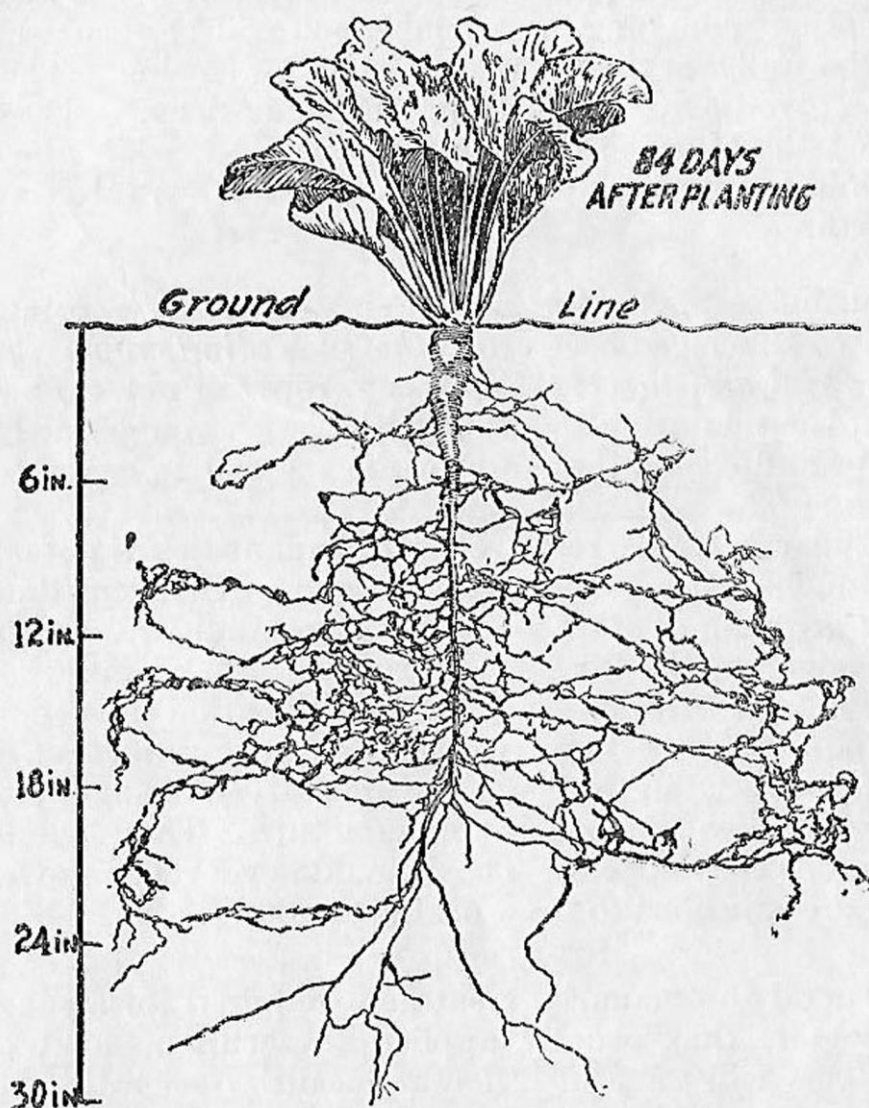


FIG. 2.—The Sugar Beet's Action on the Soil during growth.

turnips, to be followed by wheat, oats or barley and seeds. It is sometimes taken after a root crop, after a clover ley broken up early, or after peas or beans. There is no hard or fast rule for the place of sugar beet in the rotation. The farmer will decide, as with his other crops, according to the specific conditions of his own farm.

Cultivation.—The cultivation of the beet crop is similar to that required for mangolds. *Deep working is essential* in the case of sugar beet. Preparation should take place as soon after harvest as possible. As soon as the cereal crop is clear of the field, weed and other seeds begin to grow, and their growth can be encouraged by light cultivation, not more than 3 in. deep, by skim plough or cultivator. After fourteen days to three weeks the land should be thoroughly cleaned of surface rubbish. Farmyard manure (10 to 12 tons per acre) is then carted on and ploughed in deeply to a depth of 10 in. or more and the land then left to be pulverised by the winter frosts. This would avoid spring ploughing, as a friable soil will be secured which should be well worked in April in time for sowing. The roots must be given every opportunity of going deep. The under soil must therefore be thoroughly pulverised, while the upper soil should be more compact so as to give a downward direction to growth.

Manuring.—Practically all the manure in the rotation is applied to the sugar beet crop, *the succeeding crops requiring no manurial assistance*. The beet crop will not exhaust the soil and the manuring together with the thorough cultivation improves and cleans the land for the succeeding crops.

The sugar beet uses relatively large quantities of potash, but not so much nitrogen or phosphoric acid. Nitrogen stimulates the leaf growth. Potash is closely associated with the formation of sugar in the leaves. Phosphates are required less for the production of beets than for the formation of seed, which is not required in beet cultivation for sugar production. Beets which run to seed in the root year are starved in sugar content, and are useless for sugar manufacture. They should be taken out as they appear. They should never reach the factory as they are injurious to the working of good roots.

In general the manurial treatment required for a successful beet yield is that usually applied to secure a good potato crop. This will vary in different localities according to the nature and condition of the land, and the manuring of preceding crops. The experienced grower will manure his land according to his intimate knowledge of his own farm, making comparative tests to secure the best results, and no two growers will be found to act exactly alike in this respect. The following examples are therefore given with reserve, merely as an approximate guide to the new grower as to the relative values of the different manures on all soils, the quantities,

in actual practice, being increased or reduced according to the condition of the land and the variation of the soil :—

	1. <i>Heavy Soils</i>	2. <i>Medium Soils</i>	3. <i>Light Soils</i>
Farmyard Manure ..	10 to 12 tons	10 to 12 tons	10 to 12 tons
Lime	1 cwt.	2 cwt.	2-3 cwt.
Phosphates (30% to 35%)	6 cwt.	4 cwt.	2 cwt.
Potassium Salts (20%) ..	1 cwt.	3 cwt.	5 cwt.
Sulphate of Ammonia ..	1 cwt.	1 cwt.	1 cwt.
Nitrate of Soda ..	1½ cwt.	1½ cwt.	1½ cwt.

The farmyard manure and lime should be applied in the autumn, the phosphates (unless in the form of basic slag) and the potash in the spring. The sulphate of ammonia should be harrowed in when preparing the seed bed, and the nitrate of soda should be used as a surface dressing in two parts, half after the first hoeing and the rest after the singling has been completed.

Drilling.—Seed is always supplied by the factory at cost price, and only beets grown from this seed are accepted. It is not possible to lay down a fixed date for drilling, as weather conditions vary from year to year. As the factories require some of the beet of each grower early in October, it is advisable for a grower to drill part of his acreage not later than the middle of April, but it is wise not to sow earlier. If sown earlier the early mild weather encourages growth, and if the later colder weather brings growth to a standstill for a time, the roots may then develop a tendency to run to seed. Early drilling will always enable a grower to re-drill if a satisfactory plant is not obtained at the first drilling. Where a large area is grown by a farmer, he should drill at three different times at intervals of 10 to 14 days. The beets will not then require singling or hoeing at the same time, and as they also do not ripen at the same time the average sugar content at delivery is kept higher because the factory requires deliveries for manufacturing in equal quantities during the season from 1st October to 20th December. *A good seed bed is essential.* A faulty seed bed is often the cause of patchy fields of plants. Drilling in a well prepared seed bed gives the most successful results if the drilled rows are slightly pressed down by small rollers fixed behind the coulters. This has the advantage also of indicating the drilled rows, and a first hoeing can be done if found necessary even before the plants appear. The seed should be drilled on the flat in rows from 16 to 18 in. apart, preferably 16 in., and not more than 1 in. deep. Not less than 15 lb. of seed per acre should be drilled ; abroad as

much as 25 to 30 lb. are drilled. It pays to be generous with seed. This reduces the risk of poor germination and of plants being attacked by pests. It gives greater scope for securing a good "stand," that is to say, the number of good plants per acre, and thus avoids a "thin" crop. If the plant is not coming up evenly the germination can usually be assisted by rolling, preferably across the rows. If the rolling is done early in the morning it helps to keep down pests.

Hoeing.—Success in sugar beet cultivation depends very largely on the singling (thinning) and hoeing of the sugar beet crop. The object is to cause all the efforts of growth to be concentrated upon the best plants which are being isolated to create the sugar. Horse-hoeing should be done early, thoroughly and continuously until such time as it is no longer possible, owing to the rows being covered by the leaves of the plants. It should be commenced as soon as the plants in the row reveal themselves. Light draught horse hoes as used in America and Denmark are recommended. They are fitted with protecting disc coulters for the first early hoeing, replaceable by duck foot and angle tines as required. They are capable of hoeing four rows at a time, and the tines can be adjusted by the driver to allow for any irregularity in the rows. As the leaves are the sugar-producing agent care should be taken not to damage them. In hoeing, the roots, unlike mangolds, should be kept covered by soil. Uncovered roots lose sugar content. Hoeing must be maintained not only by the horse hoe between the rows, but by the hand hoe between the plants in the row. The beet crop compels the constant cleaning of the land from the moment drilling is started until the harvest begins. It necessitates special attention to the loosening of the soil between the plants. This allows light and air to penetrate the soil to the benefit of succeeding crops. Foreign experience has proved the value of this.

Singling.—When the plants show *four leaves* they should be carefully singled. Singling consists of two operations. First, bunches of plants in the row are isolated by chopping out with a hand hoe all intermediate plants between each bunch so that the bunches are 12 to 14 in. apart. The chopping-out should be at least $1\frac{1}{2}$ in. deep to clear away any seed not yet germinated, and the block should not be more than 1 in. wide. On the black fen lands, where beets are inclined to grow big and coarse, a higher sugar beet content will probably be obtained if the plants are singled 8 in. apart. The actual singling takes place by loosening the soil in the bunch so that the plants fall apart,

holding down the best plant it is intended to leave and removing all other plants and weeds in the bunch. Singling is usually paid for at piece-work rates. An experiment conducted in Germany showed the following results :—

<i>Time of Singling</i>					<i>Yield in Tons</i>
At the proper time	..	..	..	..	15 tons
One week later	..	..	..	..	13.5 „
Two weeks later	..	..	..	..	10 „
Three weeks later	..	..	..	..	7 „

It is therefore clear that the yield per acre and the percentage of sugar content depend very largely upon early and proper singling.

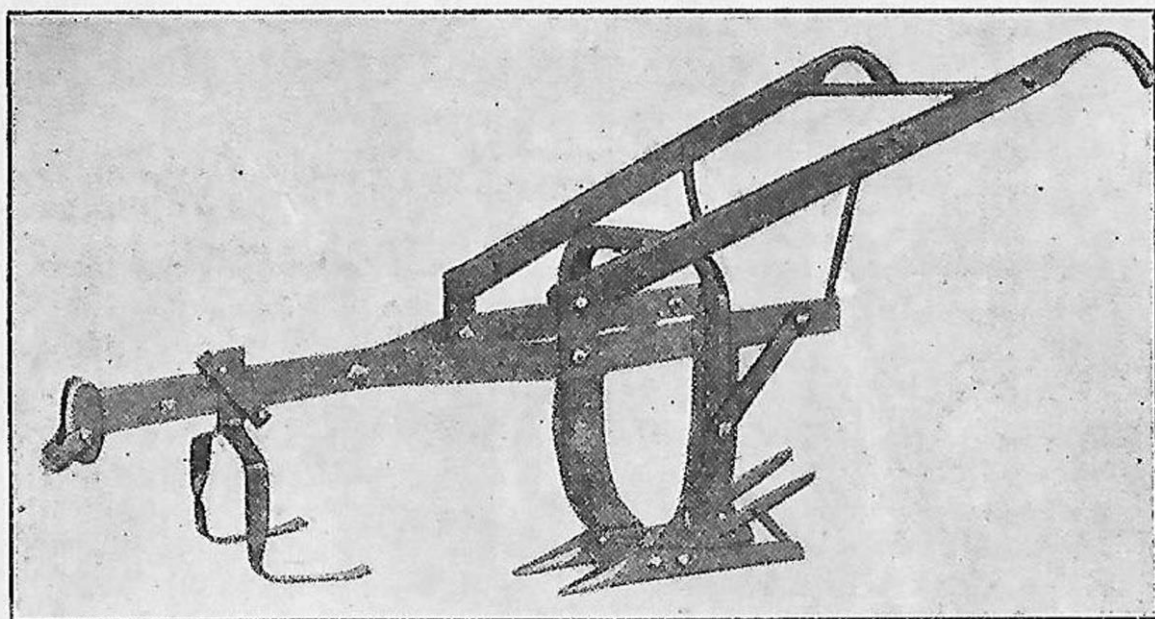


FIG. 3.—A Sugar Beet Lifter, adjustable for large or small beets.

Moisture.—A good root, that is to say, a long single root without fangs, produces the highest sugar content, because its storage qualities are the greatest. In addition, it more readily withstands drought, as it reaches down more deeply for moisture than the shorter or deformed roots.

Pests.—The sugar beet plant has been found to be less subject to attack by the mangold fly and other pests than the mangold plant.

Harvesting.—Ripeness is indicated by drooping of the leaves and their changing to a yellowish-green colour. About three-quarters of the foliage should have wilted, but the central leaves should still be fresh and green. Lifting is done by two

operations. A beet lifter (Fig. 3) is used to loosen the beets from the soil surrounding them. They are then pulled out by hand, two at a time, knocked together to remove as much soil as possible, and laid in rows or thrown into heaps. Topping (Fig. 1) is best done by one blow of a heavy knife. Unless carting is done promptly the heaps should be covered with the tops and leaves to avoid reduction of sugar content through frost or the action of the sun. When there is danger

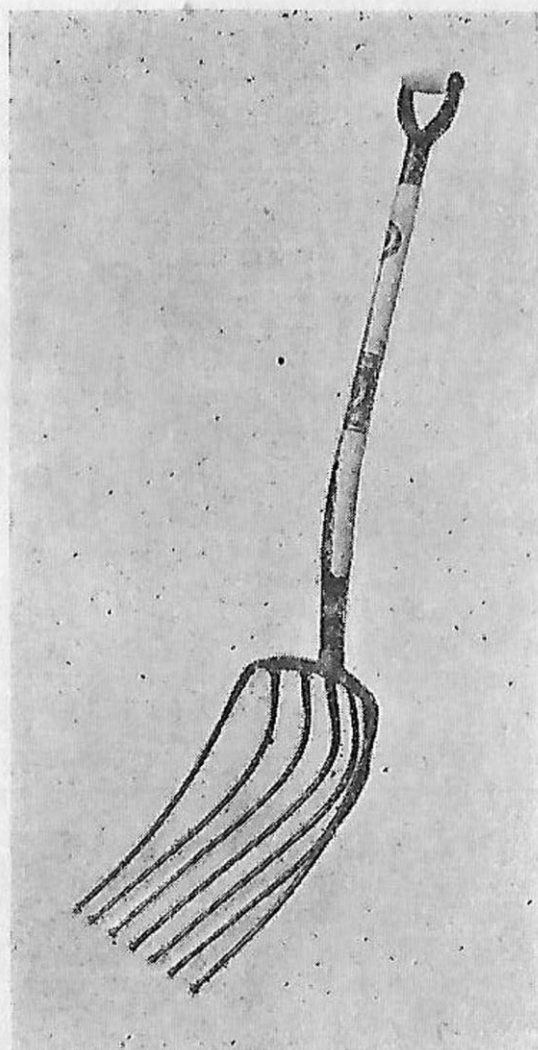


FIG. 4.—A Fork for handling Beets.

of frost they should be clamped like mangolds. Beets do not suffer from the frost before lifting. They should be thrown into the carts with beet forks (Fig. 4) having prongs with small globular ends which do not pierce the beets.

Tops and Leaves.—The tops and leaves should be left on the field. They are equal in weight to 75 per cent. of the root

when topped. If ploughed in they are of considerable manurial value, but may assist in giving new life to parasites, animal and vegetable, which live on beets, if a beet crop follows on the same land. In foreign countries they are considered of greater value if used for feeding direct off the land for cattle, sheep or pigs. It is customary abroad in the autumn to take the tops and leaves to the fields where cattle are still grazing, as they cause a heavy milk flow. They are also ensiled to serve as a winter food. They should never be fed wet or dirty, and should be used carefully as they have a somewhat laxative effect.

Yield.—The yield varies according to the land on which the beets are grown as well as the care taken in preparing the land and in the after-cultivation. A fair average crop is 8 to 12 tons of washed and topped roots. Some districts, such as the Fen country, can produce crops up to 14 or 18 tons. The lighter crops often give a comparatively greater percentage of sugar content.

Sugar Beet as a Cattle Food.—The sugar beet is used mainly for conversion into sugar and is most profitably disposed of to a factory, but it can also be used as a food for stock. *In cases where a trial crop is grown which cannot be sent to a beet sugar factory,* the crop may be fed as follows:—4 lb. of sugar beet (as topped) may be substituted for 8 lb. of mangolds or 1 lb. of cereal meals in a mixed ration. 20 to 30 lb. may be fed daily to dairy cows, as much as 50 lb. to fatting cattle, 10 lb. upwards to young cattle, and 10 lb. downwards to calves. For pigs, 1 lb. of barley can be replaced by from 4 lb. to 8 lb. of sugar beet in a mixed ration. The use of the whole sugar beetroot as a food for stock has no special value as compared with mangolds, though they are particularly suitable for pig feeding. On the other hand, the value of the tops and leaves and of the dried sugar beet pulp from the factory for this purpose cannot be over estimated.

Delivery to the Factory.—The price paid by the factory is a delivered price per ton of washed and topped beets and varies according to the sugar content in the root, as ascertained by the factory chemist. A calculation is made of the percentage of tare delivered by the grower in a fair sample which is washed and re-topped (if necessary). It is therefore to the grower's interest (a) to top correctly, and (b) to send the roots as free from dirt as possible, as he will be paying carriage upon weight for which he does not receive payment. The roots are washed

at the factory and not by the grower. As the sugar content is ascertained from a sample of the roots in the form in which they enter the factory, and as the top contains a negligible amount of sugar, if the grower does not top properly, he will also reduce the proportion the sugar content bears to the weight of the whole root. This is important to him in its effect upon his price. If his yield is low through inattention to the points set out above, he will reduce his profit per acre, as he is paid according to the actual net tonnage delivered. He should also fully load the railway trucks, as the carriage rate for beet is fixed upon a minimum load of six tons. Otherwise he will again lose through excessive carriage charges.

By-Products.—The grower is always allowed, under the beet contract, to purchase back from the factory up to 5 per cent. of the net weight of beet delivered in dried beet pulp at the special price stated in the contract. This product is the main by-product of the factory and is a valuable food for stock, increasing the yield of fattening cattle and the milk flow of dairy cows. He is thus enabled to return to his land what the sugar beet crop has taken from it, and the dried pulp acts as a substitute for the mangolds or swedes he would otherwise have grown for consumption on his own farm. This completes the agricultural circle, as it were, so that he has only taken from his land the sugar which has not drawn upon its fertility. On the contrary, the land has been made more productive for the crops following in the rotation. In foreign countries it has been proved that sugar beet increases the yield of the corn crops that follow by 10 to 15 per cent., and farmers are now beginning to testify to similar results in this country.

The Grower's Return.—In 1922 the factory offered 32s. per ton of washed and topped roots put on rail. In addition, 2s. was added or deducted proportionately for each 1 per cent. of sugar content above or below $15\frac{1}{2}$ per cent. The average sugar content over the whole crop was slightly over $16\frac{1}{2}$ per cent., so that the average return to the farmer was 34s. per ton on rail. Though costs of growing varied in different districts and according to the experience of the grower or his labour, it was acknowledged generally by the growers that their beet crop yielded a very satisfactory profit. For 1923 the price is 40s. per ton of beet delivered at the factory. There is again a variation in price if the sugar content is above or below $15\frac{1}{2}$ per cent., 2s. 6d. being added or deducted proportionately for each 1 per cent. above or below that basis. There is, however,

in 1923 a further variation according to the average sale price of sugar realised by the factory; 1s. per ton of beet is added or deducted proportionately for each 1s. or fraction thereof in the price of sugar above or below 40s. per cwt. The price of sugar at present is 54s. 6d. per cwt., so that if this be the realised price and the grower secures an average sugar content similar to that of last year, viz., $16\frac{1}{2}$ per cent., he would receive a return of 57s. per ton of washed and topped roots delivered at the factory. Allowing for a probable fall of 5s. per cwt. in the price of sugar, he would still receive 52s. as a delivered price, and as the average carriage, having regard to recent reductions in the rates, will probably be 5s. per ton, he would then receive 47s. per ton on rail for his beets instead of 34s. last year. Further reductions often accrue through delivering to the factory direct by cart or lorry, thus saving railway freight and one handling.

Cost of Production.—With regard to the cost of production, detailed costs are often misleading and can never be ascertained with accuracy for purposes of average, yet it is generally found that the total cost, whatever the variation in specific items may be, approximates the same figure. From inquiries as to experience to date, the British Sugar Beet Society came to the conclusion that £15 might be considered as a fair average cost under present conditions of growing an acre of beet and putting the produce on rail. In some cases, however, the cost has not exceeded £12. It was also found that as the greater portion of the cost of a crop of beet consists of labour, considerable economies are possible as the grower becomes more experienced. Taking specific districts, however, such as the Spalding area, the cost per acre might reach £20, but the grower, as a rule, secured a much greater yield, which has more than compensated for this additional cost. The Society also found that the average yield under normal conditions might be taken at 10 tons per acre, although on account of certain special circumstances there was a lower average yield last year, and although in the previous year, in the areas serving the Kelham factory, the average yield was higher. An acre yielding 10 tons of beet might therefore be considered to cost not more than £15, and might cost not more than £12. This gives the cost per ton of beet at 24s. to 30s. per ton on rail, and with a greater yield a lower cost still. For this reason it is desired to emphasise the importance of the notes on hoeing and singling. Each ton of yield lost through unsatisfactory cultivation seriously reduces the growers' profit.

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